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Local power, global scores: Effects of decentralization reform on Ukraine's school graduate outcomes☆,☆☆

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ABSTRACT

This paper estimates the causal effect of fiscal decentralization and newly gained spending autonomy on educational outcomes in Ukraine. Exploiting the staggered voluntary formation of amalgamated local governments (hromadas) between 2015 and 2020, we use an event-study design applied to student-level standardized exam scores for some 140 thousand graduates in 2018–2019. Decentralization improved the overall academic performance across all subjects taken for below-median students by approximately 20 percent while reducing outcomes for above-median students by roughly 5 percent, revealing an equity-excellence trade-off. The effects are heterogeneous across subjects: decentralization improved STEM achievement across the entire performance distribution, whereas in the humanities, gains for lower-performing students were offset by losses among high achievers. The reform's benefits were concentrated in lower-income hromadas, where an expanded fiscal base and greater local control over education spending drove the largest improvements. Urban hromadas experienced stronger performance gains than rural ones, where teacher shortages may have constrained the reform's effectiveness. Overall, the findings indicate that decentralization reform has been a significant force for reducing educational disparities; however, complementary investments, particularly in teacher quality, are needed to realize the reform's full potential and to support high achievers.

1. Introduction

Fiscal decentralization, the transfer of revenue authority and spending responsibilities to subnational governments, is one of the most widely adopted governance reforms in developing and transitional economies. The theoretical case is well established: local governments can better observe community needs and match public spending to local preferences (Lastra-Anadón and Mukherjee, 2019). Yet empirical evidence on whether decentralization actually improves public service delivery remains mixed, particularly in education. Some studies find that greater fiscal and administrative autonomy improves student outcomes, especially when accompanied by targeted resource allocation (O'Brien and Paczynski, 2006; Carneiro et al., 2015; Lafortune et al., 2018; Kreisman and Steinberg, 2019). Others show that the returns depend heavily on local management capacity and may be modest even in well-resourced settings (Sarwar et al., 2022; Nicoletti and Rabe, 2018; Gibbons et al., 2018). This tension between the promise and the limitations of local fiscal autonomy motivates our study.

This paper estimates the causal effect of Ukraine's decentralization reform on secondary school graduate exam performance. Starting in 2015, Ukrainian law allowed communities to voluntarily amalgamate into newly formed local governments (hromadas), granting them substantial fiscal autonomy. Specifically, amalgamated hromadas received a significantly expanded revenue base and direct authority over local spending decisions — rather than tax-rate-setting power — including a 60 percent share of locally collected personal income tax and full control over school financing (see Section 2 for details; Arends et al., 2023; Ministry of Regional Development, Construction, Housing and Communal Services of Ukraine, 2017). All local communities had to

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form a hromada by 2020. Because communities amalgamated at different times between 2015 and 2020, the reform generates staggered, quasi-exogenous variation in when local governments assumed authority over education spending. We exploit this variation to identify the reform's impact on student achievement.

Our estimation sample comprises 140,032 student-level observations from the 2018 and 2019 cohorts of Ukraine's External Independent Evaluation (EIE), a standardized university entrance examination administered at the hromada level. We focus on these two cohorts for two reasons. First, a sufficient number of hromadas had been formed by 2018–2019 to generate meaningful variation in treatment duration, allowing us to estimate dynamic effects over two- to four-year horizons. Second, COVID-19 disruptions and Russia's subsequent full-scale invasion in 2022 make it essential to exclude post-2019 data to avoid confounding. We estimate cohort-specific dynamic treatment effects using the interaction-weighted estimator of Sun and Abraham (2021).

Our results suggest that decentralization raises average EIE scores, but the aggregate masks sharp heterogeneity across the achievement distribution. Below-median students improve by approximately 20 percent in the year of reform implementation, while above-median students experience a statistically significant decline of around 5 percent. The pattern suggests resource reallocation: local governments, once granted fiscal autonomy, directed spending toward schools and students with the greatest room for improvement, a channel consistent with the broader consensus linking targeted funding increases to gains among lower-performing students (Lafortune et al., 2018; Kreisman and Steinberg, 2019). Correlational analysis provides evidence of a positive and statistically significant association between per-school educational expenditures and test scores, supporting the plausibility of increased local investment as a mechanism linked to improved performance.

The research further suggests that the effects are asymmetric across subjects. STEM performance improves across the entire ability distribution, with extraordinary gains of roughly 50 percent for the below-median students and modest but significant improvements even for top performers. Humanities scores, by contrast, exhibit a zero-sum pattern: gains for weaker students come at the expense of stronger ones. This divergence is consistent with the distinction drawn by OECD (2018): physical and technical inputs such as laboratories and equipment can serve students at all levels simultaneously, whereas humanities instruction depends more heavily on teacher time and curricular choices that may require trade-off between foundational support and advanced programming.

The reform's benefits are concentrated in previously disadvantaged areas. Students in below-median-income hromadas experience the largest gains, and the share of students crossing the median achievement threshold rises significantly in poorer communities. Wealthier hromadas, which likely operated near adequate resource levels under the centralized system, show minimal gains or modest declines. Urban hromadas translate fiscal autonomy into measurable improvements more effectively than rural ones, where persistent shortages of qualified teachers, particularly in STEM fields, limit the ability to convert increased spending into instructional quality (Kupets, 2011, 2013; Lücke and Saha, 2019; OECD, 2018). An analysis of normalized differences of hromada characteristics across amalgamation cohorts confirms that early decentralizers had *lower* baseline test scores than later cohorts.

This study makes two main contributions to the literature on fiscal decentralization and education. First, we provide the first, to the best of our knowledge, causal estimates of decentralization effects on educational outcomes in a post-Soviet transitional context, where both the potential gains from local preference-matching and the risks from weak institutional capacity are particularly salient. Ukraine's reform process constitutes an ongoing effort of state-building conducted under the constraints of an active military conflict in its eastern regions (that started in 2014), offering insights that differ fundamentally from those derived from established democracies or the developing-country contexts that dominate the existing literature (O'Brien and Paczynski, 2006; Kazungu and Mabula, 2013; Carneiro et al., 2015).

Second, using student-level data linked to hromada fiscal records, we document heterogeneous effects across (1) the full academic achievement distribution, (2) subjects of study, (3) hromada income levels, (4) settlement types, and (5) school types. Prior causal studies of education decentralization have examined distributional effects across schools or districts differing in baseline resources (e.g., Galiani et al., 2008), but not across students at different points of the achievement distribution within the same local government. Our finding of an equity-excellence trade-off — where below-median students gain while above-median students lose — is a dimension that aggregate outcome measures cannot reveal.

The paper proceeds as follows. First, Section 2 discusses Ukraine's decentralization reform and its educational governance implications. Then, Section 3 presents the data, while the empirical strategy is described in Section 4. Next, we present the event study results on the causal effects of decentralization in Section 5, followed by Section 6 that interprets these findings and examines educational spending as a plausible mechanism. Finally, Section 7 offers conclusions and policy recommendations.

2. Ukraine's decentralization reform and educational governance

Ukraine's decentralization reform, initiated following the 2014 Revolution of Dignity, represented the most fundamental restructuring of subnational governance in the country's post-independence history. Prior to the reform, Ukraine operated under a Soviet-era three-tier system in which oblast (regional), rayon (district), and municipal governments shared administrative responsibilities, but local units retained minimal fiscal autonomy (Chumak and Shevliakov, 2009). Revenue sharing was negotiated annually at the center, creating soft budget constraints and weakening incentives for local revenue mobilization (International Monetary Fund, 2019).

The 2014–2015 legislative reforms fundamentally altered this architecture. The Law on the Voluntary Amalgamation of Territorial Communities (Verkhovna Rada of Ukraine, 2015) enabled existing villages, settlements, and small cities to merge into unified amalgamated territorial communities, hromadas, and thereby gain access to a substantially enlarged fiscal base. Upon amalgamation, hromadas became direct recipients of 60 percent of personal income tax (PIT) collected on their territory (compared to near-zero under the prior system), gained authority over agricultural land taxes, and received enhanced equalization transfers from the State Budget (Arends et al., 2023). As a result, local revenues and development spending grew dramatically: by 2017, many amalgamated hromadas had increased their own revenues by approximately 80 percent (versus 32 percent nationally), and per-capita development expenditures more than tripled relative to pre-reform levels (Ministry of Regional Development, Construction, Housing and Communal Services of Ukraine, 2017).

Amalgamation was voluntary until 2020. Communities could apply to the regional state administration for approval to merge, subject to geographic contiguity and minimum population thresholds (Wright and Slukhai, 2021; OECD, 2018). The first cohort of hromadas was registered in 2015; by the end of 2019, over 1000 amalgamated communities had been established, covering approximately 43 percent of Ukraine's territory (Romanova and Umland, 2019; Wright and Slukhai, 2021). The remaining communities were administratively amalgamated by central decree in 2020 (Wright and Slukhai, 2021; Arends et al., 2023).

The timing of amalgamation was not random. The pioneer hromadas that formed in 2015–2016 were venturing into uncharted institutional territory with no guarantee the reform would endure, and their formation required local political entrepreneurship and grassroots civic mobilization (Arends et al., 2023). Research indicates that communities with higher pre-reform per capita income were significantly more

likely to amalgamate early, as retaining 60 percent of locally collected personal income tax made fiscal autonomy most attractive where the tax base was already substantial (Romanova and Umland, 2019; Wright and Slukhai, 2021). Historical legacies also mattered: communities in western Ukraine, where traditions of local self-governance dating to Austro-Hungarian and Polish rule persisted, showed greater willingness to amalgamate than communities in regions with longer tradition of centralized Soviet administration (Ford, 2020). In addition, the central government incentivized early adoption through infrastructure subventions earmarked for amalgamated hromadas, with state support for hromada development rising from 0.5 billion UAH in 2014 to 14.9 billion UAH by 2017 (International Monetary Fund, 2019). Conversely, larger and wealthier urban centers often resisted merging with surrounding poorer communities, fearing that their revenues would be diluted, while small rural communities feared losing transfers from rayon authorities (Wright and Slukhai, 2021). This selection pattern, whereby early adopters tended to be more fiscally capable and institutionally prepared, is important context for interpreting our event study estimates, and we return to it in the Discussion.

Prior to amalgamation, school financing flowed through rayon education departments, which allocated funds across schools with limited input from individual settlements (Kudelia and Samokhin, 2018; World Bank, 2019). Teacher hiring, salary supplements, and capital maintenance decisions were made at the rayon level (Kudelia and Samokhin, 2018). Communities had neither the fiscal resources nor the formal authority to direct spending toward locally preferred educational priorities (Chumak and Shevliakov, 2009; Kudelia and Samokhin, 2018). The increase in educational spending observed after amalgamation therefore reflects a transfer of authority over existing revenue streams, from rayon departments to hromada councils, combined with the fiscal incentive effects of the 60 percent PIT retention, rather than an injection of new central government funding.

Upon amalgamation, hromada councils acquired formal competence over primary and secondary schools within their territory (Swedish International Centre for Local Democracy, 2024). Hromadas are general-purpose local governments responsible for education alongside other public services including infrastructure, social welfare, and land management. In terms of scale, hromadas in our estimation sample range from small rural communities with fewer than 10 students taking the EIE exam to urban centers with several hundred; the median early-amalgamating hromada has approximately 108 students, while later cohorts are larger (see Table 2). In scope, they are closer to local education authorities in England than to US school districts, as they govern education as one of several service areas within a defined territory. Hromada councils gained authority over per-pupil supplementary spending, teacher incentive pay, infrastructure repair, and school network organization, including deciding whether to consolidate smaller schools or maintain them. Teacher base salaries remained centrally administered, but the combination of fiscal autonomy and administrative responsibility created the conditions under which local communities could meaningfully invest in educational infrastructure and quality (OECD, 2018). The democratic, bottom-up formation of new hromadas also generated significant increases in citizens' trust toward local authorities and boosted civic participation, as evidenced by increased voter turnout in local elections (Arends et al., 2023; Swedish International Centre for Local Democracy, 2024).

Ukraine's reform shares structural features with decentralization episodes elsewhere in post-communist Europe. During the Soviet era, Eastern European countries operated under centralized systems that concentrated power at the national level and systematically discouraged local autonomy (Zsamboki and Bell, 1997; Horváth, 2000). The collapse of communism in the early 1990s triggered a wave of decentralization reforms as newly democratic governments sought to dismantle centralized control and build responsive local governance institutions (Swianiewicz, 2014; Zsamboki and Bell, 1997).

Poland pioneered this transformation, implementing sweeping local government reforms in 1990 and deepening them in 1998 to create powerful self-governing regions with substantial fiscal and administrative authority (Regulski, 2003; Levitas, 2017). By the early 2000s, OECD's PISA studies indicated that these reforms had propelled Poland to academic performance levels comparable with Finland and Canada (O'Brien and Paczynski, 2006). Hungary and the Czech Republic similarly restructured their governance systems during the 1990s, establishing municipal autonomy with varying degrees of fiscal decentralization and administrative capacity (Horváth, 2000; Swianiewicz, 2014). Ukraine's reform, launched two decades later, followed this regional trajectory but in a distinct context, combining post-Soviet institutional legacies with the pressures of state-building and, eventually, active military conflict.

Indeed, the institutional strength cultivated through decentralization has proven consequential beyond peacetime governance. Research indicates that hromadas with higher social capital and greater inter-community cooperation demonstrated superior budget robustness during Ukraine's resistance to Russian aggression (Rabinovych et al., 2024a, 2024). Decentralized communities managed to mobilize local knowledge, resources, and innovation, thereby sustaining schooling despite widespread damage (Keudel and Huss, 2024). However, the war has also introduced centralizing pressures through expanded military administration roles, creating tensions between local autonomy and emergency coordination (Rabinovych et al., 2025). These wartime dynamics underscore both the resilience enabled by decentralization and the ongoing challenges of maintaining local capacity under extraordinary circumstances. While these crisis-period outcomes demonstrate decentralization's ultimate value, they also highlight why isolating the reform's peacetime effects by excluding post-2019 observations is methodologically essential.

3. Data

To investigate the impact of the reform on student learning, we assemble a pooled cross-section data set covering the universe of Ukrainian students who took the External Independent Evaluation (EIE) test during 2018–2019. This data comes from Ukrainian Center for Educational Quality Assessment (UCEQA) (Ukrainian Center for Educational Quality Assessment, 2025). Student performance is measured by student scores on the EIE test, a nationwide university entrance exam administered by the Ukrainian Center for Educational Quality Assessment. The EIE data set also provides data on place of residence and study of students, their sex, age, school type, and whether they are graduates of the year when they take the test. We restrict the sample to students who completed secondary school in the same calendar year as their exam. Individuals who graduated in earlier years are excluded. We then further restrict the sample to 16–21-year-olds to ensure that the estimated effects pertain to typical, recent graduates — the primary population affected by school-level policies. Excluding older examinees mitigates compositional changes arising from adult education, migration, or re-entry, which could otherwise bias estimates of the decentralization reform's impact on student achievement. Zadorozhna and Badunenko (2026) provide the data and the replication package.

In Ukraine's EIE examinations, each student first receives a raw (actual) test score equal to the number of points earned on the test form. This raw score is a direct, criterion-referenced measure of performance and is the most transparent indicator of how many items a student answered correctly. Because it precedes any statistical adjustments, it is unaffected by scaling choices and is therefore our primary outcome when we seek to measure absolute achievement.

For reporting and admissions, the testing authority applies a two-step adjustment procedure. First, it sets a pass/fail threshold using a hybrid Angoff–Beuk standard-setting method: expert judgments about the performance of a minimally competent graduate (Angoff) are reconciled with the observed score distribution from the live cohort (Beuk)

Table 1
Distribution of students in decentralized hromadas vs. not decentralized.

Year	Not decentralized		Decentralized	
	Number	Percent	Number	Percent
2018	48,801	70.9%	20,052	29.1%
2019	41,863	58.8%	29,316	41.2%
Total	90,664	64.8%	49,368	35.2%

to establish a cohort-appropriate cut. Second, raw scores at or above the threshold are mapped to the official 100–200 scale, a monotone transformation used in university admissions to facilitate comparability across subjects and years. This creates a common reporting metric while preserving the rank order among passers. In our study, we use raw scores as the baseline outcome to avoid confounding from standard-setting and scaling.

We merge student test results with hromada-level variables — such as hromada revenues and expenditures — from the Open Data Portal of the Ministry of Finance (Ministry of Finance of Ukraine, 2025). Financial variables are available only starting from 2018 and only for hromadas that became decentralized. This is the main reason why our sample starts in 2018 and not earlier. Financial records are matched to student test scores by settlement and region names; where duplicate settlement names occur within a region, we drop those ambiguous cases.

Using inflation data from the State Statistics Service of Ukraine (State Statistics Service of Ukraine, 2025), we convert nominal financial variables to real terms. Hromada-level decentralization status is taken from the KSE Local Data Hub (Brik et al., 2025). The final dataset comprises 140,032 student test scores for 2018–2019. We exclude observations from 2020 onward to prevent confounding arising from the COVID-19 pandemic and Russia's full-scale military invasion of Ukraine on 24 February 2022. Our analysis exploits the staggered roll out of the reform – some hromadas formed and gained fiscal autonomy earlier than others – to identify its causal effect on test outcomes. We employ an event study design that compares changes in student performance in a hromada before vs. after it adopts the decentralized governance.

Table 1 demonstrates the progressive implementation of Ukraine's decentralization reform across the study period. In 2018, approximately 29% of students in our sample attended schools in decentralized hromadas, rising to 41% by 2019. This staggered roll out is crucial for our identification strategy, as it provides variation in treatment timing across communities. By 2020, the decentralization reform was completed nationwide, with all hromadas in our sample having undergone the transition. Notably, the 2018–2019 period, when approximately 65% of students remained in not-yet-decentralized hromadas, provides the critical comparison group for our event study analysis, allowing us to identify the causal effect of decentralization by comparing outcomes in early-adopting versus late-adopting hromadas during the transition period.

Because amalgamation was voluntary until 2020, a natural concern is that communities which decentralized early differ systematically from those that decentralized later. Table 2 addresses this by comparing hromada-level characteristics across three amalgamation cohorts: early voluntary (2015–2017, 194 hromadas), late voluntary (2018–2019, 91 hromadas), and compulsory (2020, 254 hromadas). Early decentralizers scored *lower* than both later cohorts on every test-score measure, with normalized differences (Imbens and Wooldridge, 2009) ranging from −0.15 to −0.53 (Panel A). They are also smaller and less urban (Panel B), consistent with the resistance of larger urban centers to amalgamation (Wright and Slukhai, 2021), while their higher fiscal capacity (Panel C) reflects the PIT retention incentive discussed in Section 2. This combination is consistent with the legacy of rayon-level school administration, under which smaller and more rural communities had limited influence over the allocation of educational resources within their territory (Kudelia and Samokhin, 2018; World Bank, 2019).

During 2018–2019, EIE employed a unique dual-compulsory structure where Ukrainian Language and Literature served as the sole universally compulsory subject for all graduating students, while students had to select either Mathematics or History of Ukraine as their second compulsory examination. This structure reflects an attempt to balance standardized assessment requirements with some degree of student choice, allowing students to align their compulsory testing with their intended university specialization — STEM-oriented students typically selecting Mathematics, while humanities-focused students often choose History of Ukraine. However, in practice, many students opt to take all three examinations (Ukrainian Language and Literature, Mathematics, and History of Ukraine), either to keep multiple university pathways open or because their intended programs require scores in all three subjects, creating a *de facto* triple-compulsory system for a significant portion of test-takers as evidenced in our dataset.

Beyond these compulsory assessments, students selected additional elective subjects based on their intended university specialization and career aspirations, creating a hybrid testing system that accommodated individual academic trajectories. Students pursuing STEM fields typically added elective examinations in Physics, Chemistry, Biology, or Geography while those oriented toward humanities may have selected Foreign Languages (commonly English, German, French, or Spanish) as separate examinations. This flexible structure allowed universities to evaluate applicants based on subject-specific knowledge relevant to their programs while maintaining a common linguistic foundation across all graduates.

Fig. 1 presents the distribution of average test scores across all subjects for the entire 2018–2019 sample period. The distribution exhibits a pronounced right-skewed pattern, with the modal performance concentrated between 20 and 35 points. This substantial mass of students in the lower-to-middle achievement range suggests that the typical Ukrainian graduate scores well below the theoretical maximum, indicating considerable room for educational improvement. The distribution shows a relatively smooth decline from the peak toward higher scores, with a notable tail extending to approximately 80–90 points, though very few students achieve scores above 80.

This distributional shape has important implications for our analysis of decentralization effects. The concentration of students in the 20–50 point range implies that policy interventions improving general instructional quality, school infrastructure, or basic educational resources would affect the largest segment of the student population. Conversely, the thin right tail suggests that only a small fraction of students achieve elite performance levels, making this group particularly vulnerable to changes in specialized programming or advanced educational offerings. The skewness also indicates that the gains from decentralization would likely be most detectable and strongest within the dense middle portion of the distribution, where even modest gains in test scores could benefit large numbers of students, while effects at the top-end would involve relatively fewer students but may signal important excellence concerns.

Table 3 presents summary statistics for average test scores across different subject categories from 2018 to 2019, revealing several important temporal and subject-specific patterns. The median scores (p50) across years consistently fall in the 33–41 point range for most aggregate measures, with approximately half of students scoring below these thresholds — precisely the population our analysis identifies as benefiting from decentralization. A persistent and striking performance gap emerges between subject areas: humanities subjects consistently outperform STEM subjects by 9–10 points across all years, with Mathematics showing particularly low scores (mean equal to around 25 points). This substantial STEM underperformance, evident even at the 95th percentile where STEM scores (61 points) lag behind humanities scores (around 78 points), highlights a systemic challenge in Ukrainian STEM education that decentralization alone appears insufficient to address. The relatively stable median and percentile values

Table 2
Summary statistics of hromada cohorts.

	Early (2015–2017)		Late (2018–2019)		Compulsory (2020)		Norm. diff.	
	Mean	SD	Mean	SD	Mean	SD	E–L	E–C
Panel A: Test scores (hromada means)								
All subjects sat	35.15	6.84	36.78	6.05	37.22	6.94	−0.252	−0.301
STEM subjects	30.17	7.31	31.68	5.56	32.03	6.25	−0.234	−0.273
Humanities subjects	40.22	7.85	41.65	6.70	42.06	7.76	−0.196	−0.237
Ukrainian language	44.51	10.62	46.53	9.04	47.88	10.80	−0.204	−0.314
Mathematics	19.22	6.67	22.33	6.38	22.65	6.20	−0.477	−0.533
History of Ukraine	37.87	6.01	38.73	5.38	39.56	5.24	−0.150	−0.298
Panel B: Student composition (hromada means)								
Share female	0.479	0.216	0.490	0.128	0.489	0.165	−0.063	−0.049
Mean age	17.468	0.433	17.429	0.291	17.533	0.371	0.106	−0.162
Share urban	0.437	0.484	0.603	0.481	0.707	0.445	−0.343	−0.580
Number of students	108.077	137.425	424.132	871.030	316.807	477.870	−0.507	−0.594
Panel C: Hromada fiscal characteristics								
Ed. expenses per school (ln, real)	16.698	0.630	16.245	0.880	–	–	0.591	–
Ed. expenses per pupil (ln, real)	14.528	1.353	13.825	1.188	–	–	0.552	–
Total income p.c. (ln, real)	8.979	0.361	8.877	0.326	–	–	0.295	–
Number of hromadas	194		91		254			

Notes: Each observation is a hromada. Variables are hromada-level means computed from the pooled 2018–2019 student-level sample. The compulsory cohort (amalgamated by central decree in 2020) is included for comparison; it serves as part of the not-yet-treated comparison group in our estimation sample. Columns E–L and E–C report normalized differences (Imbens and Wooldridge (2009)): $\Delta = (\bar{x}_1 - \bar{x}_2)/\sqrt{(s_1^2 + s_2^2)/2}$. Financial variables are available only for decentralized hromadas and are therefore missing for the compulsory cohort in 2018–2019.

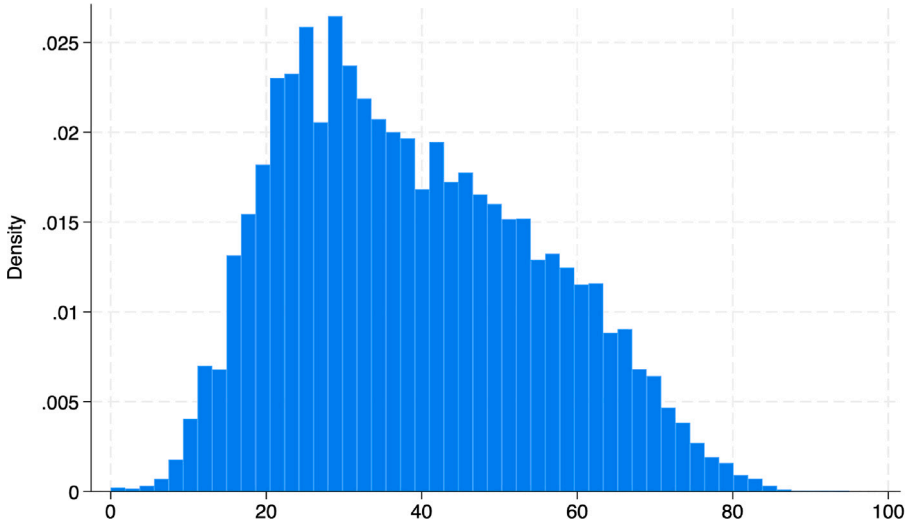

Fig. 1. Distribution of average test scores over 2018–2019, all subjects sat.

across 2018–2019 suggest that the median score represents a natural and consistent dividing line for examining heterogeneous treatment effects across the achievement distribution. The distributional stability within each year indicates that splitting the sample at the median would capture meaningful and persistent achievement groups rather than transitory classifications driven by year-specific test difficulty variations, making this threshold well-suited for identifying differential impacts of decentralization on below-median versus above-median performers.

We also analyze the temporal evolution of income per capita and educational expenses per school at the hromada level, extending the sample to 2021 for broader context, illustrated in Fig. 2. While per capita income grew steadily but modestly — rising from approximately 8000 UAH to just over 10,000 UAH, representing roughly a 25% increase — educational expenses per school experienced far more dramatic growth, rising from around 15 million UAH in 2018 to approximately 21 million UAH in 2020 before declining to 17.5 million UAH in 2021. This divergence indicates that education spending grew substantially faster than hromada income during the period of fiscal decentralization. Because teacher base salaries are funded centrally through the education subvention rather than from hromada budgets (World Bank, 2019; European Education and Culture Executive Agency, 2024), the observed increase in hromada-level educational expenditure reflects growth in discretionary local spending, which may include school maintenance and repairs, instructional materials, teacher bonus pay, or school network reorganization (Kudelia and Samokhin, 2018; OECD, 2018). Our data do not disaggregate expenditures into these categories, so we cannot identify which components drove the increase. Nonetheless, the temporal alignment between the spending surge and the strongest gains among below-median students in our event-study estimates is consistent with increased local educational investment as a plausible channel, which we examine further in Section 6. The subsequent moderation in 2021 may reflect the completion of initial capital outlays, pandemic-related budget adjustments, or both.

The time-series comparison of average test scores between decentralized and not-yet-decentralized hromadas displayed on Fig. 3 reveals several important descriptive patterns that motivate our formal causal

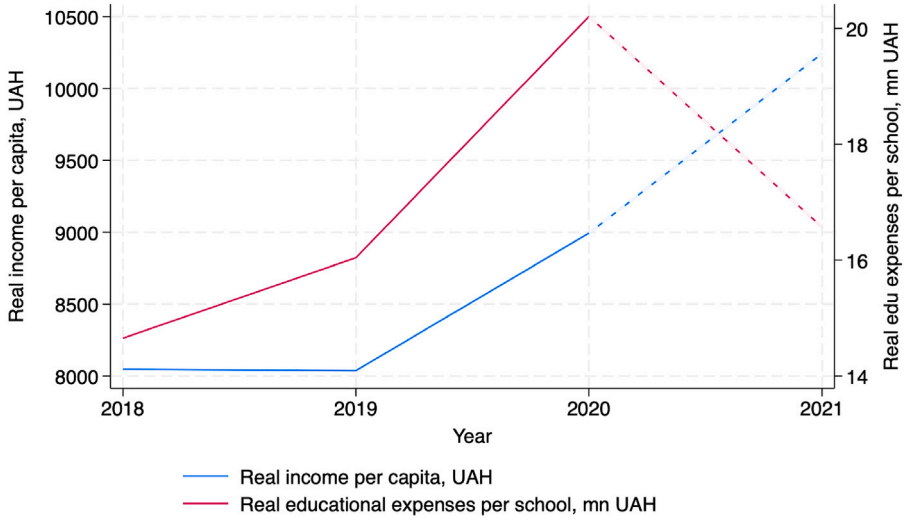

Fig. 2. Time series of hromada-level real income per capita and educational expenses per school over 2018–2021.
Notes: Financial variables are available only for decentralized hromadas from 2018 onward.

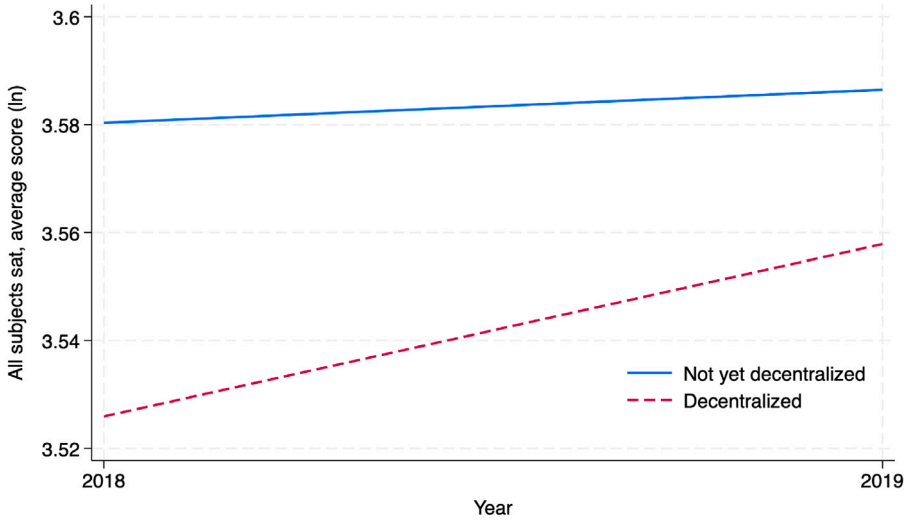

Fig. 3. Time-series of the average scores for all subjects sat.
Notes: The natural logarithm of average scores of all subjects sat is displayed on vertical axis. The blue line represents an average score of all subjects sat in hromadas not yet decentralized, while the red dashed line — in decentralized hromadas. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

analysis. In 2018, students in not-yet-decentralized hromadas (blue solid line) scored slightly higher on average (approximately 3.58 in log-points) than their counterparts in already-decentralized communities (red dashed line, approximately 3.53 in log-points), suggesting that early-adopting hromadas may have had somewhat lower baseline achievement levels. However, this gap narrows substantially by 2019, with decentralized hromadas showing notable improvement while not-yet-decentralized communities remained relatively stable. Importantly, the red line shows an upward trajectory from 2018 to 2019, while the blue line remained flat, provides preliminary visual evidence consistent with positive decentralization effects. The logarithmic scale on the vertical axis implies that these differences represent percentage changes in test scores, with the approximately 0.03 log-point increase in decentralized hromadas between 2018 and 2019 corresponds to a gain of about 3% in average performance.

4. Empirical strategy

To provide causal inference in event study settings with staggered adoption, we use the approach developed by Sun and Abraham (2021). This event study methodology augments difference-in-differences (DiD) designs with staggered treatment timing, i.e., accounting for the circumstances when different units receive treatment at different times. Traditional two-way fixed effects (TWFE) models can produce biased estimates in such settings due to negative weighting and heterogeneous treatment effects (Callaway and Sant'Anna, 2021; Sun and Abraham, 2021). The proposed Interaction-Weighted (IW) estimator estimates cohort-specific event-time effects, comparing treated units to a consistent control group (units not yet treated) thereby avoiding contamination from already treated units acting as controls.

In our study, the outcome variable has multiple hierarchical levels, like individual i, school type s, settlement type u, hromada h (level at which treatment occurs), and time t, and treatment occurs at the hromada level (with staggered adoption across hromadas). The outcome variable therefore has five indices Y_{isuht}. Let G_h be the time period when hromada h is treated, $D_{ht} = \mathbf{1}\{t \geq G_h\}$ be the hromada-level treatment indicator, and $e = t - G_h$ be the event time relative to treatment in hromada h. Further define event-time indicators for each treated cohort

Table 3
Summary statistics of average test scores by year (2018–2019).

	N	mean	sd	min	max	p5	p50	p95
Year 2018								
Compulsory subjects	68,841	41.5	19.0	0.0	100.0	16.0	38.5	75.0
All subjects sat	68,853	39.0	16.4	0.0	95.0	16.0	37.0	68.0
STEM subjects	48,310	34.3	15.0	0.0	94.0	11.0	33.0	61.0
Humanities subjects	68,838	43.6	19.5	0.0	104.0	17.0	41.3	77.7
Ukrainian Language	68,773	51.3	25.5	0.0	104.0	16.0	49.0	92.0
Mathematics	26,451	25.2	14.5	0.0	62.0	6.0	23.0	51.0
History of Ukraine	40,120	41.8	15.5	0.0	94.0	22.0	38.0	73.0
Year 2019								
Compulsory subjects	71,169	41.2	18.3	0.0	97.5	15.5	38.0	73.5
All subjects sat	71,179	39.3	16.2	0.0	93.0	15.7	37.3	68.0
STEM subjects	52,682	33.7	15.7	0.0	92.0	9.0	33.0	61.0
Humanities subjects	71,120	44.0	19.1	0.0	104.0	18.3	41.0	78.0
Ukrainian Language	70,857	49.1	25.0	0.0	104.0	15.0	45.0	91.0
Mathematics	33,820	25.0	13.7	0.0	62.0	7.0	23.0	49.0
History of Ukraine	49,647	41.0	14.9	1.0	94.0	21.0	39.0	71.0

Notes: Compulsory subjects include Ukrainian Language and Literature, Mathematics and History of Ukraine. Students could choose whether to sit Mathematics or History of Ukraine as the second compulsory subject along with Ukrainian Language and Literature. The majority of students in our sample chose to sit all three subjects, therefore, we grouped them together as compulsory. STEM subjects include Mathematics, Physics, Chemistry, Biology, and Geography. Humanities subjects include Ukrainian Language and Literature, History of Ukraine, and Foreign Language subjects such as English, German, Spanish etc.

g (a group of hromadas treated in the same period):

$$\mathbf{1}\{G_h = g, t - G_h = e\}$$

These indicators equal 1 if hromada h belongs to cohort g and is observed at relative time e, i.e., periods after being treated. Note that e can be negative implying periods before being treated. The equation to be estimated becomes:

$$Y_{isuht} = \sum_{e \neq -1} \sum_{g \in \mathscr{G}} \beta_e^{(g)} \cdot \mathbf{1}\{G_h = g, t - G_h = e\} + \mathbf{X}'_{isuht}\gamma + \lambda_t + \delta_u + \theta_s + \psi_h + \varepsilon_{isuht}, \tag{1}$$

where Y_{isuht} represents the natural logarithm of the average test score for student i attending school type s in settlement type u, in a hromada h at time t. $\mathbf{X}_{isuht}$ is a vector of control variables that includes: Female_i is a dummy variable equal one for female students, and zero otherwise; Age_i measures student age in years; and $\ln(\text{Income}_{ht})$ is the logarithm of real per capita income in hromada h at time t; $\ln(\text{EdExp}_{ht})$ is the logarithm of educational expenses per school in hromada h at time t, adjusted for inflation. The specification includes four sets of fixed effects: θ_s represents school fixed effects, which absorb all time-invariant characteristics of individual schools (e.g., historical quality, infrastructure, location-specific factors); δ_u is a categorical variable representing type of a settlement in which the school s is located (i.e., city, town, or village), ψ_h denotes hromada fixed effects, controlling for unobserved time-invariant community characteristics; and λ_t captures year fixed effects, accounting for nationwide temporal shocks such as curriculum changes or exam difficulty variations. The error term ε_{isuht} captures idiosyncratic variation in student performance. In this equation, $e = -1$ is omitted to normalize the coefficients.

The aggregated IW estimator computes the overall event-time effects as follows:

$$\hat{\beta}_e^{IW} = \sum_{g \in \mathscr{G}_e} w_{g,e} \cdot \hat{\beta}_e^{(g)} \tag{2}$$

where $\hat{\beta}_e^{(g)}$ is the estimated effect at event time e for cohort g and $w_{g,e}$ is the weight. One way to obtain the weight is to take into account the number of observations in cohort g at event time e. Finally, since treatment is at the hromada level, standard errors are clustered at the hromada (h) level to account for arbitrary correlation in outcomes within hromadas over time and across schools and students.

The baseline outcome is the logarithm of an average student's raw (actual) test score, i.e., the number of points prior to application of the Angoff-Beuk pass/fail threshold and the subsequent 100–200 rescaling. As a robustness check, we re-estimate Eqs. (1) and (2) using three alternative outcomes: (i) the official 100–200 score; (ii) a within-year standardized z-score of the raw score; and (iii) the student's within-year national percentile of the raw score. The results are qualitatively unchanged relative to the baseline and are omitted for brevity.

In our estimations, we include only students who study in decentralized hromadas from 2018–2019, before the nationwide completion of decentralization in 2020. We focus on this pre-completion period for two key reasons. First, Table 1 suggests that approximately 29% in 2018 and 41% in 2019 were decentralized, implying that in our regressions we include only those hromadas that consciously and purposely went from command to community, allowing us to gain first glance of a "purified" decentralization effect on educational outcomes. Second, extending the sample through 2021 would contaminate our results with COVID-19 pandemic effects, which disrupted both educational delivery and testing patterns beginning in 2020.

5. Results

5.1. All students, all subjects

We begin by examining the impact of decentralization reform on performance for all students. Even though our interest is in estimating an "average" effect, we also seek to understand how the reform influences worse and better performers. More specifically, we categorize students into two performance groups: 'low' performers, or those students whose test scores are below the median in their respective year, and 'high' performers, or students whose test scores are above the median.

The dependent variable is the natural logarithm of the average test score across all subjects a student sat as part of their EIE. Fig. 4 summarizes event-study estimates of the reform's impact on student scores for three groups: (1) all students, (2) 'low' performers, and (3) 'high' performers.

We find that Ukraine's decentralization reform resulted in significant improvements in student test performance on average. However, the effects are heterogeneous across the distribution of test scores. Each plotted effect tracks the difference in outcomes between reformed and not-yet-reformed hromadas in the years leading up to and following decentralization, with 95 percent confidence intervals. Hromadas decentralized in 2020 act as a control group for the ones decentralized earlier.

The leftmost panel in Fig. 4 shows that on average, students in decentralized hromadas experienced an immediate and significant improvement of approximately 15% in average test scores in the year of reform implementation (denoted by $L(0)$ on the vertical axis), though this effect attenuates in subsequent years and becomes statistically insignificant.[1] The middle panel demonstrates that below-median performers benefited most substantially from decentralization, with a highly significant 20% increase in test scores at $L(0)$ and marginally significant persistence at $F(2)$,[2] suggesting that increased local educational authorities effectively addressed the needs of struggling and

[1] Because the specification is log–level, the estimated coefficient, say $\hat{\beta} = 0.15$, can be interpreted as an approximate 15% effect. More precisely, the implied percentage effect is $(\exp(\hat{\beta}) - 1) \times 100\%$, which in this case equals approximately 16.2%.

[2] $F(2)$ denotes the outcome two periods ahead, that is, two periods after treatment. Similarly, $F(1)$ denotes the outcome one period ahead and $L(0)$ denotes the outcome in the year of decentralization.

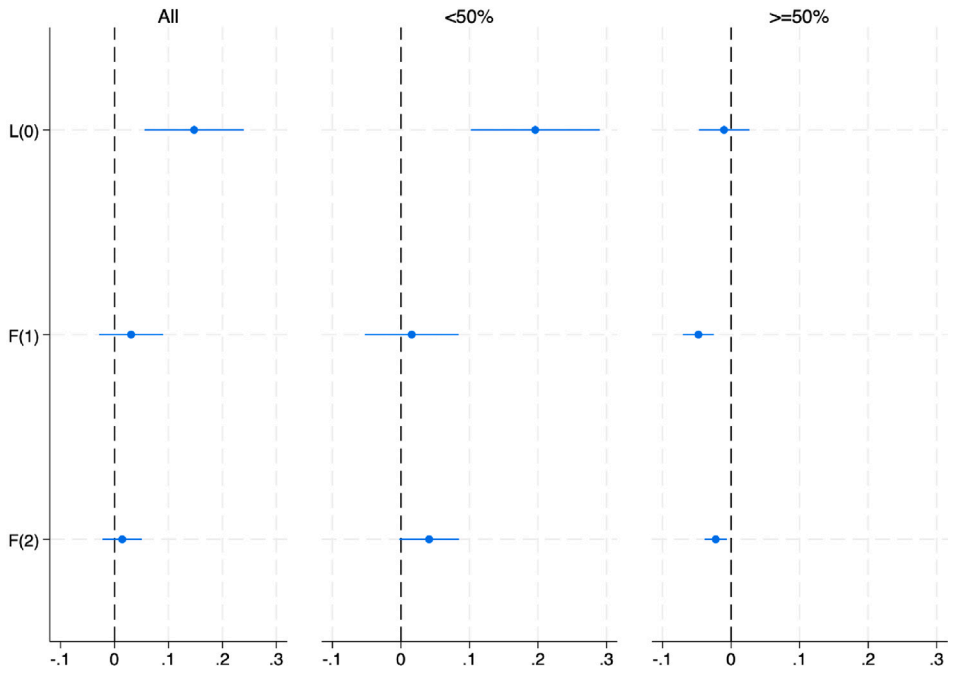

Fig. 4. Event study results — average scores (ln), all subjects sat.
Notes: The Figure presents the results of the event study model for the dependent variable natural logarithm of average scores for *All subjects sat.* The plotted coefficients are generated using Eqs. (1) and (2). The leftmost panel presents the results for all students. The middle panel presents the results for the students with scores below median over 2018–2019. The rightmost panel shows the results for the student with scores above median over 2018–2019. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

average students. Most strikingly, the rightmost panel reveals that above-median performers experienced statistically significant declines in test scores following decentralization, with negative effects of about 5% at $F(1)$ and 2% at $F(2)$. This divergent pattern suggests that while decentralization enabled local authorities to prioritize broad-based educational improvements that lifted the majority of students, it may have reduced support for high achievers.

The temporal pattern — characterized by a strong immediate effect at $L(0)$ that attenuates over subsequent periods — is suggestive of a front-loaded reform impact. Upon amalgamation, hromadas experienced a substantial fiscal shock that enabled rapid investments in educational inputs, including instructional materials, school repairs, and supplementary resources (Ministry of Regional Development, Construction, Housing and Communal Services of Ukraine, 2017). These investments helped alleviate resource deficits that had accumulated under centralized governance, generating the largest gains in the first year, when the gap between available resources and educational needs was greatest.

5.2. Compulsory subjects

Estimating the reform's average effect on all students — and on the average test score across all subjects — may mask heterogeneity across student subgroups and subject areas. Some subjects may matter more to students, for example when applying for jobs or seeking university admission. That is why we next estimate the results for each compulsory subject separately.

Fig. 5 examines the reform's impact on Ukrainian Language and Literature, Mathematics, and History of Ukraine — revealing patterns consistent with the main findings while highlighting important subject-specific variations that reflect both the opportunities and limitations of fiscal decentralization. The leftmost panels show divergent average effects across the subjects. The policy has had a positive effect at $L(0)$ on Ukrainian Language and Literature and History of Ukraine test scores, while there is no significant average improvement in Mathematics, underscoring persistent challenges in mathematics instruction that decentralization alone could not address.

The middle panels demonstrate that below-median performers experienced significant gains in Ukrainian Language and Literature and History of Ukraine (by around 20%), with positive coefficients appearing at $L(0)$ and continuing through subsequent periods, suggesting that decentralization effectively improved foundational skills in language-based subjects through enhanced local resource allocation. However, even below-median performers in Mathematics show limited or no significant improvements, highlighting a critical constraint: while decentralization granted hromadas fiscal autonomy to invest in education, many communities — particularly in rural areas — may have struggled to recruit qualified mathematics teachers immediately due to persistent brain drain and the migration of skilled professionals to urban centers or abroad (Kupets, 2011, 2013; Lücke and Saha, 2019).

The rightmost panels in Fig. 5 reveal that above-median performers experienced significant declines across all three compulsory subjects following decentralization, potentially indicating the relocation of support away from high-achievers across the entire core curriculum. The increased local budgets could purchase textbooks and equipment, but could not overcome the fundamental challenge of attracting and retaining qualified mathematics teachers, especially in rural communities competing with higher-paying opportunities in urban areas or international labor markets (Kupets, 2011, 2013; Lücke and Saha, 2019). Looking beyond our 2018–19 study window, the growing experimentation with AI-assisted instruction in Ukrainian schools suggests a prospective path to broaden individualized support — particularly in math — should implementation challenges be addressed (The Junior Academy of Sciences of Ukraine, 2023).

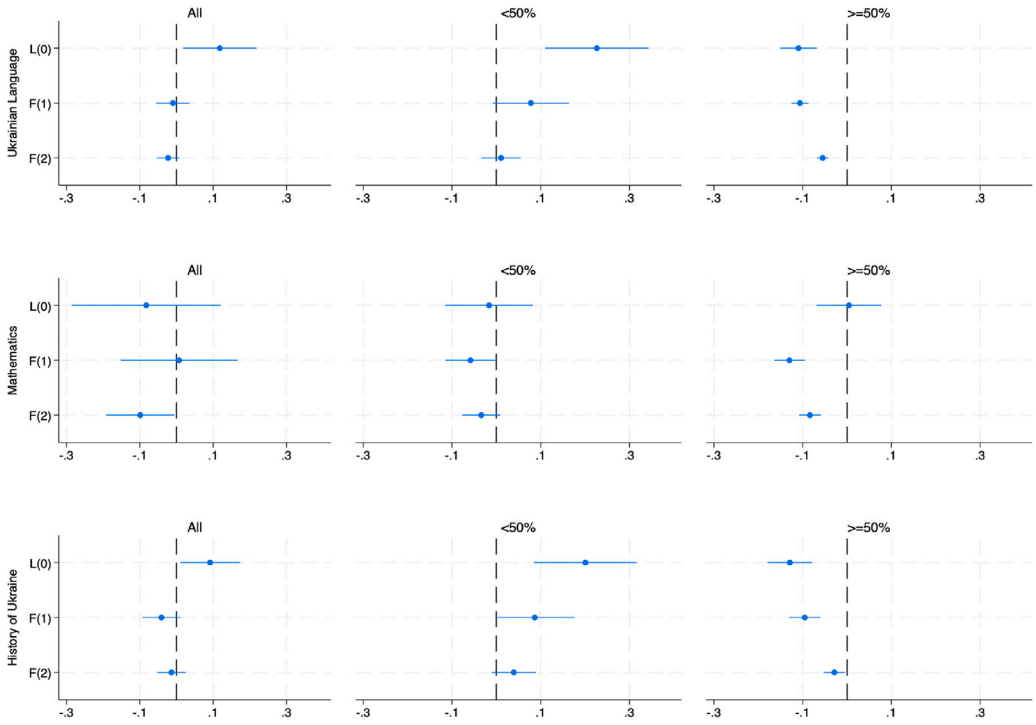

Fig. 5. Event study results — average scores (ln), compulsory subjects.
Notes: The Figure presents the results of the event study model for the dependent variable natural logarithm of average scores for *Ukrainian language and Literature* (top row), *Mathematics* (middle row), and *History of Ukraine* (bottom row). The plotted coefficients are generated using Eqs. (1) and (2). The leftmost vertical panel presents the results for all students. The middle vertical panel presents the results for the students with scores below median over 2018–2019. The rightmost vertical panel shows the results for the student with scores above median over 2018–2019. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

5.3. STEM vs. Humanities

To further explore heterogeneity in policy effects, we disaggregate EIE average test scores into STEM and humanities subjects. Fig. 6 contrasts these domains and reveals fundamentally different mechanisms through which decentralization affected student outcomes. The top row examining STEM subjects shows strong and equitable effects: below-median performers experienced extraordinary significant gains of about 50% at $L(0)$ with sustained positive effects of 4.4% at $F(1)$ and 7.2% at $F(2)$, while above-median performers also benefited modestly with small but significant gains of 3.4% at $F(1)$ and 2.3% at $F(2)$. This demonstrates that decentralization successfully enhanced STEM instruction across the entire achievement distribution, substantially narrowing gaps by helping struggling students far more than top performers while still lifting all boats. Interestingly, these results are not driven by Mathematics (which is included in the average STEM test score), as evidenced by Fig. 5, but by other STEM subjects.

On the other hand, the bottom row in Fig. 6 examining humanities subjects reveals a zero-sum pattern: below-median performers gained 15.7% at the time of treatment, $L(0)$, but these improvements failed to persist significantly one and two years after the treatment, $F(1)$ and $F(2)$. At the same time, above-median performers experienced significant and sustained declines of 6.2% at $L(0)$, 8.8% at $F(1)$, and 4.2% at $F(2)$, confirming the main result. The divergence between STEM and humanities is notable. STEM resources — such as laboratory equipment, digital learning tools, and science materials (OECD, 2018) — are physical inputs that, once acquired, can serve students across the ability distribution simultaneously. Humanities instruction, by contrast, depends more heavily on teacher time and curricular design, which are inherently rival: hours devoted to foundational literacy support for struggling students are hours unavailable for advanced programming (Gardner, 2015; Cordeiro Guerra and Lastra-Anadón, 2019). This distinction is consistent with the broader finding that equity and excellence goals in education often compete for the same scarce resources, with local decision-makers tending to prioritize equity when it offers more immediate and visible returns (Cordeiro Guerra and Lastra-Anadón, 2019). The pattern we document suggests that decentralization intensified this trade-off in humanities, where local authorities appear to have redirected support toward foundational skills at the expense of high-achieving students.

5.4. Urban vs. rural hromadas

Fig. 7 examines whether the reform affected educational outcomes differently in urban and rural hromadas. The left panels show results for urban areas across all subjects (top), STEM (middle), and humanities (bottom). Urban below-median performers experienced positive effects, particularly in STEM subjects, while urban above-median students show small negative or insignificant coefficients. The magnitudes are modest compared to the aggregate results, consistent with urban schools having smaller baseline deficits to address given their better infrastructure and greater access to qualified teachers (OECD, 2018). Nonetheless, urban hromadas appear to have successfully leveraged decentralization to improve outcomes for struggling students while partially mitigating negative effects on top performers.

The three rightmost vertical panels in Fig. 7 presenting rural results reveal more muted effects that are largely insignificant due to huge variation reflecting significant heterogeneity in rural schools. Indeed rural schools can be as small as having 1 student taking EIE test per year and as large as having 88 students taking this test. The rural

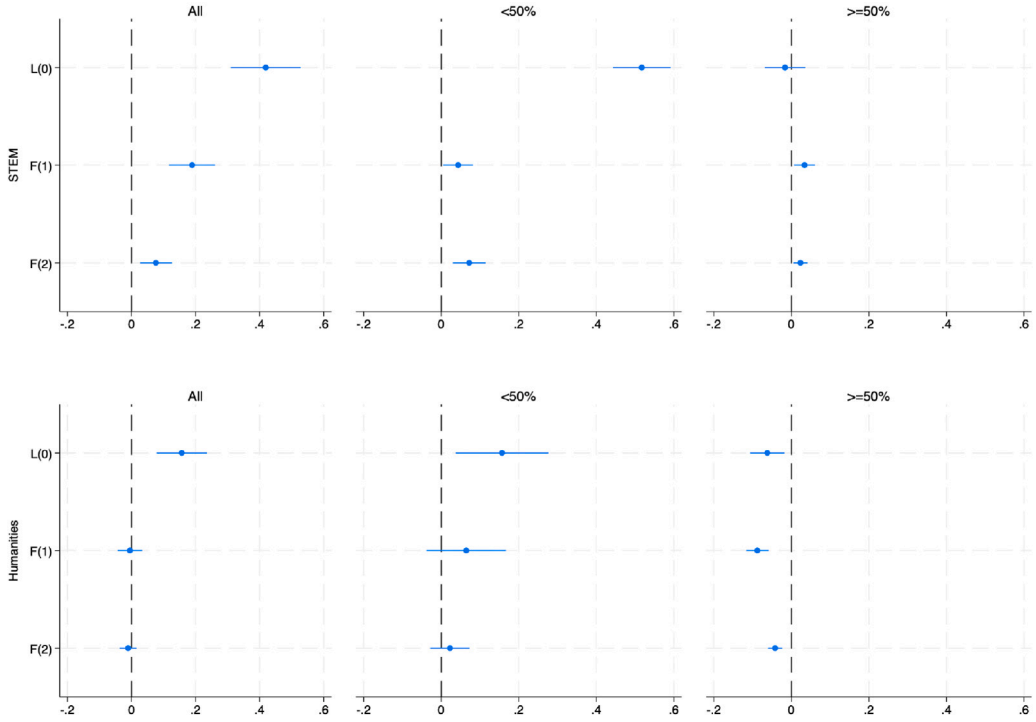

Fig. 6. Event study results — average scores (ln), STEM vs. Humanities.
Notes: The Figure presents the results of the event study model for the dependent variable natural logarithm of average scores for *STEM subjects* vs. *Humanities subjects*. The plotted coefficients are generated using Eqs. (1) and (2). The leftmost vertical panel presents the results for all students. The middle vertical panel presents the results for the students with scores below median over 2018–2019. The rightmost vertical panel shows the results for the student with scores above median over 2018–2019. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

below-median performers show smaller gains than their urban counterparts, particularly in STEM subjects where the shortage of qualified mathematics and science teachers is most acute (OECD, 2018), while rural above-median performers experienced declines comparable to or exceeding those in urban areas.

The urban-rural divide highlights an important limitation of decentralization reform. Although greater budgetary autonomy may help communities invest in education, its benefits depend on local implementation capacity. In our setting, urban hromadas appear better positioned to convert additional resources into improved student outcomes, whereas rural hromadas show weaker and more heterogeneous effects. This finding is in line with the broader literature on the urban-rural divide in Ukraine, which documents persistent disparities in school infrastructure, access to qualified teachers, and local capacity between urban and rural communities (Kupets, 2011, 2013; OECD, 2018). Our results therefore suggest that decentralization is more effective where administrative capacity and educational resources are already stronger, while rural hromadas may require additional targeted support for the reform's benefits to fully materialize.

5.5. Hromada income level

Fig. 8 examines a distinct dimension: hromada income level. Many low-income hromadas are rural, but the two categories do not fully overlap — some urban hromadas have below-median income, and some rural hromadas have above-median income. The income split captures differences in *fiscal capacity*, whereas the urban/rural split captures differences in *implementation capacity*, particularly access to qualified teachers. The left panels presenting results for below-median income hromadas show strong positive effects for struggling students across all subjects at $L(0)$, with particularly large gains in STEM subjects. This result indicates that relatively poorer communities which likely experienced the largest proportional revenue increases from gaining fiscal autonomy and retaining 60% of PIT, prioritized basic educational infrastructure and instructional improvements that benefited below-median performers the most. However, these gains in relatively poorer hromadas came at the expense of significant declines for above-median students.

The rightmost panels in Fig. 8 presenting results for above-median income hromadas reveal predominantly negative or statistically insignificant effects across the achievement distribution. The below-median students show minimal or no gains, while above-median students experienced declines comparable to or exceeding those in relatively poorer communities. This pattern suggests that more affluent hromadas, which already possessed adequate educational resources under the centralized system, gained little additional benefit from fiscal autonomy and may have even suffered disruption costs from the administrative transition to decentralized governance.

Fig. 9 complements the findings from Fig. 8 by examining whether the test score improvements in poorer hromadas translated into increased shares of students crossing the median achievement threshold. The leftmost vertical panel showing results for below-median income hromadas reveals significant positive effects across all subjects: the share of students scoring above the median increased by around 12% at $L(0)$ and persisted through $F(1)$ and $F(2)$, particularly pronounced in STEM subjects where poorer communities achieved the largest gains for struggling students. This demonstrates that the test score improvements documented earlier were sufficiently large to move meaningful

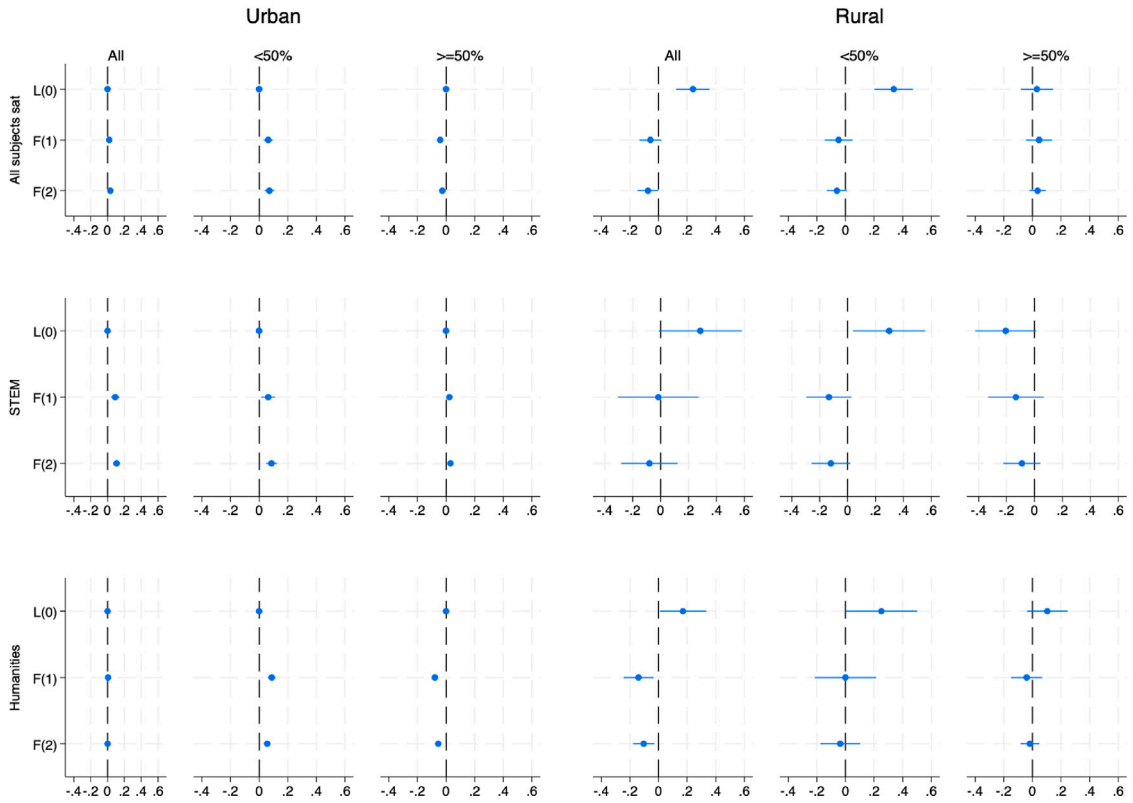

Fig. 7. Event study results — urban vs. rural, average scores (ln).
Notes: The Figure presents the results of the event study model for the dependent variables natural logarithm of average scores for *All subjects sat* (top row), *STEM* (middle row), and *Humanities* (bottom row). The plotted coefficients are generated using Eqs. (1) and (2). The first and fourth vertical panels present the results for all students. The second and fifth vertical panels present the results for the students with scores below median over 2018–2019. The third and sixth vertical panel shows the results for the student with scores above median over 2018–2019. The first three vertical panels present the results for urban areas. The second three vertical panels present the results for rural areas. Urban areas include all the cities and urban type settlements, while rural areas include villages and rural-type settlements. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

numbers of below-median students above the median threshold, indicating educational mobility and achievement gains rather than merely marginal improvements within the lower half of the distribution. The rightmost vertical panel showing results for above-median income hromadas reveals negligible or slightly negative effects on the share of students scoring above median, with coefficients hovering near zero or dipping below, consistent with the finding that wealthier communities experienced minimal benefits from decentralization.

This pattern provides more evidence that fiscal decentralization functioned as an equity-enhancing mechanism: relatively poorer communities not only improved average test scores for struggling students but successfully moved substantial proportions of their student populations from below-median to above-median performance, narrowing achievement gaps between disadvantaged and affluent areas. The particularly strong effects in STEM subjects for relatively poorer hromadas suggest that targeted investments in laboratory equipment, science materials, and mathematics instruction — made possible by increased local revenues (OECD, 2018) — enabled previously under-resourced communities to dramatically improve their students' technical competencies and competitive positioning for higher education and skilled employment.

5.6. School type

Finally, Fig. 10 examines whether the reform's effects differed by school type, contrasting regular secondary schools with specialized institutions (liceums, gymnasiums, and other types of schools). The left-side three panels presenting results for secondary schools show strong positive effects for below-median students across all subjects at $L(0)$, with sustained but more modest improvements through $F(1)$ and $F(2)$, particularly pronounced in STEM subjects, while above-median students experienced modest declines. This demonstrates that regular secondary schools — which serve the vast majority of Ukrainian students and typically operated with fewer resources under centralized governance — made the most of fiscal decentralization to improve educational outcomes for struggling students likely through investments in basic infrastructure, instructional materials, and teaching resources.

In contrast, the right-side three panels in Fig. 10 shows that specialized schools achieved positive gains for below-median students while above-median students experienced mixed outcomes — positive effects in STEM subjects but effects hovering near zero in humanities. This suggests that specialized schools — benefiting from more qualified teachers, stronger baseline resources, and selective student populations — could have partially leveraged fiscal autonomy to invest in foundational improvements while avoiding the substantial declines in top-performer outcomes that characterized regular secondary schools, particularly in technical subjects where their superior infrastructure and teacher quality provided advantages. The modest preservation of above-median outcomes in specialized schools, rather than dramatic improvements across all subjects, indicates that even elite institutions faced constraints in simultaneously pursuing equity and excellence,

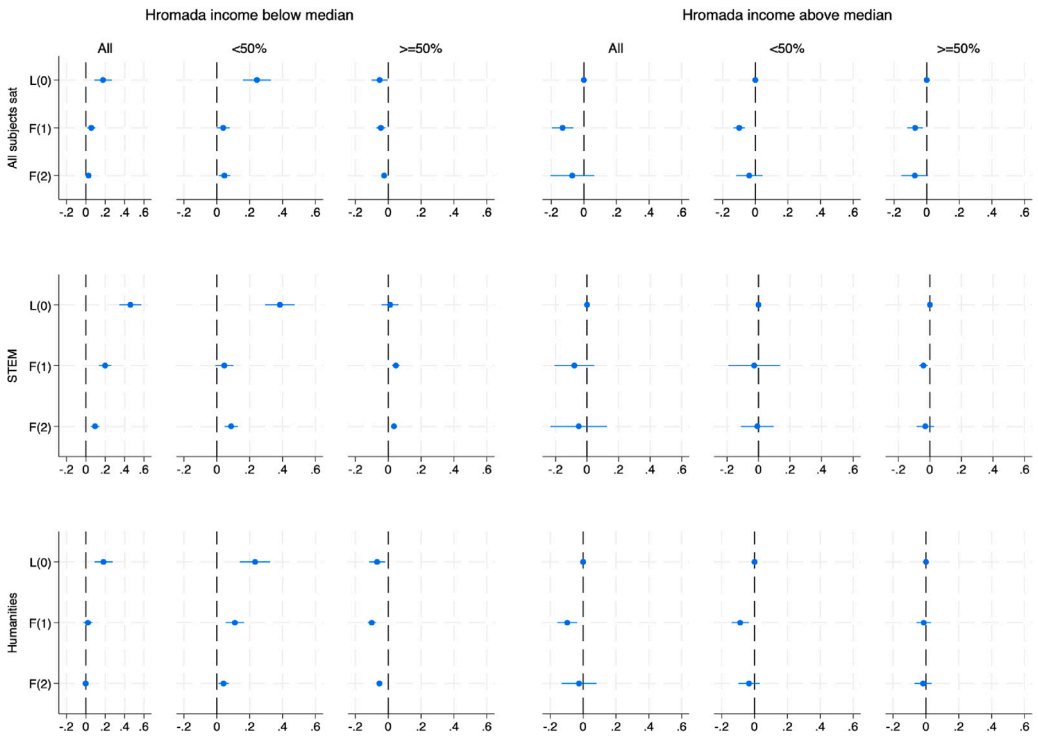

Fig. 8. Event study results by hromada income, average scores (ln).
Notes: The Figure presents the results of the event study model for the dependent variables natural logarithm of average scores for *All subjects sat* (top row), *STEM* (middle row), and *Humanities* (bottom row). The plotted coefficients are generated using Eqs. (1) and (2). The first and fourth vertical panels present the results for all students. The second and fifth vertical panels present the results for the students with scores below median over 2018–2019. The third and sixth vertical panel shows the results for the student with scores above median over 2018–2019. The first three vertical panels present the results for hromadas with income below median. The second three vertical panels present the results for hromadas with income above median. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

though these trade-off were less severe than in regular schools. The findings indicate that while specialized schools managed decentralization's challenges more successfully than typical secondary schools, the limited gains for top performers underscore that fiscal autonomy alone, even in favorable institutional contexts, struggles to simultaneously advance both equity and excellence agendas without substantial additional resources or complementary policies.

6. Discussion

Our analysis reveals that Ukraine's decentralization reform produced heterogeneous effects that underscore the complex relationship between fiscal autonomy and educational equity. Three key findings emerge from our research.

First, the reform redistributed educational gains across the performance distribution, improving equity while introducing new trade-off. Below-median students experienced meaningful and sustained gains in Ukrainian Language and Literature and History of Ukraine, suggesting that enhanced local resource allocation improved foundational skills. In contrast, above-median students saw consistent declines across all three compulsory subjects, while Mathematics outcomes remained largely unchanged across the distribution. This pattern indicates that decentralization successfully targeted resources toward struggling students but may have done so at the expense of support for higher achievers.

This equity-enhancing pattern contrasts with findings from other decentralization contexts. Trounstine (2018) documents that in the United States, decentralization of local governance tends to *increase* inequality, as local authorities are more easily captured by organized interest groups that steer resources toward already-advantaged populations. In Ukraine, the opposite occurred: newly formed hromadas directed resources toward struggling students and under-resourced schools. This difference may reflect the distinct institutional setting. Ukrainian hromadas were created through a democratic, bottom-up process that generated broad civic participation and increased trust in local authorities (Arends et al., 2023; Swedish International Centre for Local Democracy, 2024), potentially limiting the elite capture that characterizes more established local governments. Moreover, the finding that below-median performers benefited most is consistent with the mechanism identified by Cordeiro Guerra and Lastra-Anadón (2019): during periods of decentralization, newly empowered local bureaucracies face pressure to demonstrate early results, and the outcomes most easily moved tend to be those of disadvantaged students. In the Ukrainian case, this pressure appears to have channeled resources toward foundational skills and basic infrastructure — investments that yield visible improvements for the lowest performers but offer less to students already near the top of the distribution.

Second, local prioritization decisions reshaped the balance between STEM and humanities instruction. Decentralization led to strong and sustained gains in STEM subjects, especially among below-median performers, with modest improvements even for top achievers. These effects were driven by non-mathematics STEM subjects, suggesting that investments in science resources — laboratories, equipment, or specialized instruction — benefited a broad range of students. Humanities subjects, however, followed a zero-sum pattern: short-term gains for lower performers were offset by persistent declines among higher achievers. This divergence likely reflects local authorities prioritizing

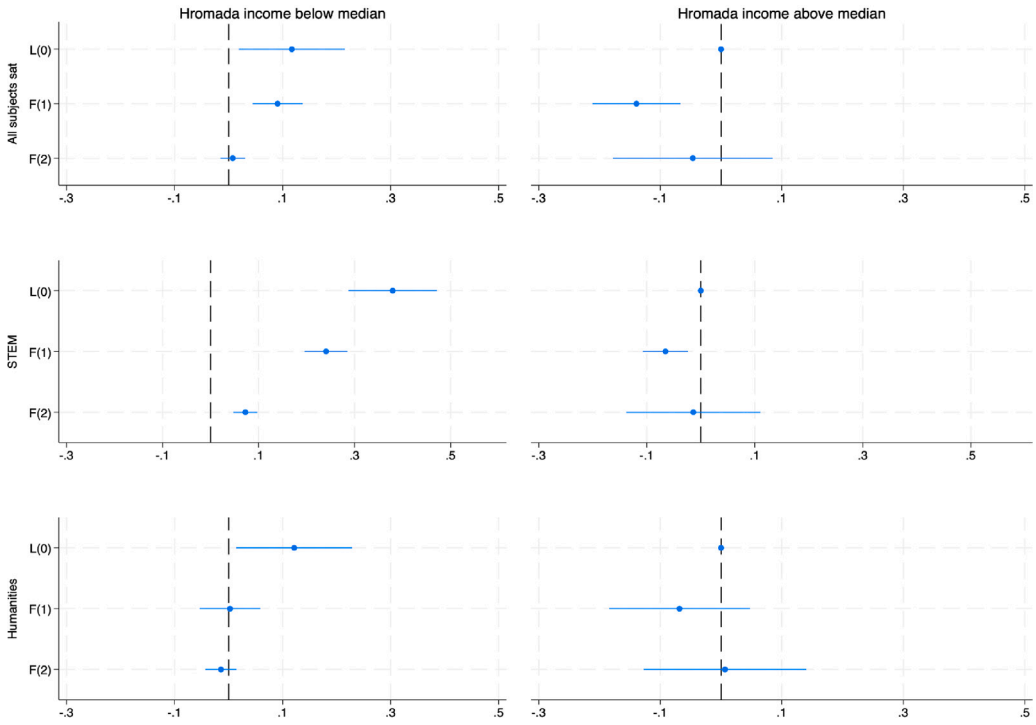

Fig. 9. Event study results by hromada income, share of students with average scores (ln) above median.
Notes: The Figure presents the results of the event study model for the dependent variables share of students with average scores above median for *All subjects sat* (top row), *STEM* (middle row), and *Humanities* (bottom row). The plotted coefficients are generated using Eqs. (1) and (2). The leftmost vertical panel presents the results for hromadas with income below median. The rightmost vertical panel presents the results for hromadas with income above median. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

foundational support and STEM investment over advanced humanities instruction, reshaping the distribution of excellence across disciplines.

Third, the reform's effectiveness was highly sensitive to local context. Urban students were largely unaffected, whereas rural students experienced notable declines, particularly in STEM subjects. Yet the income-based pattern reveals a more nuanced story: students in relatively poorer hromadas saw improved outcomes, while those in affluent areas experienced minimal gains or modest declines. School-type heterogeneity mirrors these income-based patterns, suggesting that institutional characteristics interacted with socioeconomic context to shape reform outcomes. This finding implies that decentralization's benefits were concentrated in previously under-resourced communities that could most effectively translate increased revenues into educational improvements. Wealthier areas, possibly already operating near optimal resource levels, experienced the administrative costs of reform without commensurate gains.

The decline among top performers warrants particular attention, as it runs counter to expectations that increased resources would benefit all students. In Ukraine's educational context, high-achieving students often rely heavily on private tutoring to excel in standardized exams. The observed decline may reflect a substitution effect: as public school quality improved for general instruction, affluent families — believing public education would now suffice — could have reduced private tutoring investments. This would particularly affect students in compulsory subjects where families previously supplemented public instruction. Alternatively, decentralized hromadas may have deliberately shifted focus from gifted programs toward general instruction, reallocating resources away from specialized support that previously benefited top performers. The exception in STEM subjects, where top performers improved, suggests that targeted investments in advanced STEM resources (specialized labs, equipment, or competitions) may have complemented rather than replaced private tutoring, creating synergies absent in humanities subjects. Conversely, below-median students, who are less likely to afford private tutoring, depend more heavily on the quality of public schooling. When hromadas invested in educational improvements, these investments disproportionately benefited students who relied most on public provision. While we lack strong evidence on private tutoring expenditures in Ukraine, this pattern is consistent with the well-documented role of private supplementary tutoring — or "shadow education" — in reinforcing achievement stratification: higher-income families purchase tutoring that supplements public schooling, while lower-income students depend almost entirely on publicly provided instruction (Bray, 2009; Buchmann et al., 2010). Improvements in public provision therefore disproportionately benefit students without access to private alternatives.

These patterns highlight a fundamental tension in educational decentralization: reforms that successfully target resources toward equity may inadvertently reduce support for excellence. The interaction between public school improvements and private educational investments creates complex dynamics that vary by subject and socioeconomic context. Future research should explore these dynamics more directly, examining how changes in public school quality affect private tutoring demand and expenditure, and investigating whether decentralized systems can be designed to simultaneously support both equity and excellence across disciplines.

6.1. Educational spending as a channel

A natural question is what mechanism links the institutional change of decentralization to the student-level outcomes documented above. The most plausible channel is increased local educational investment

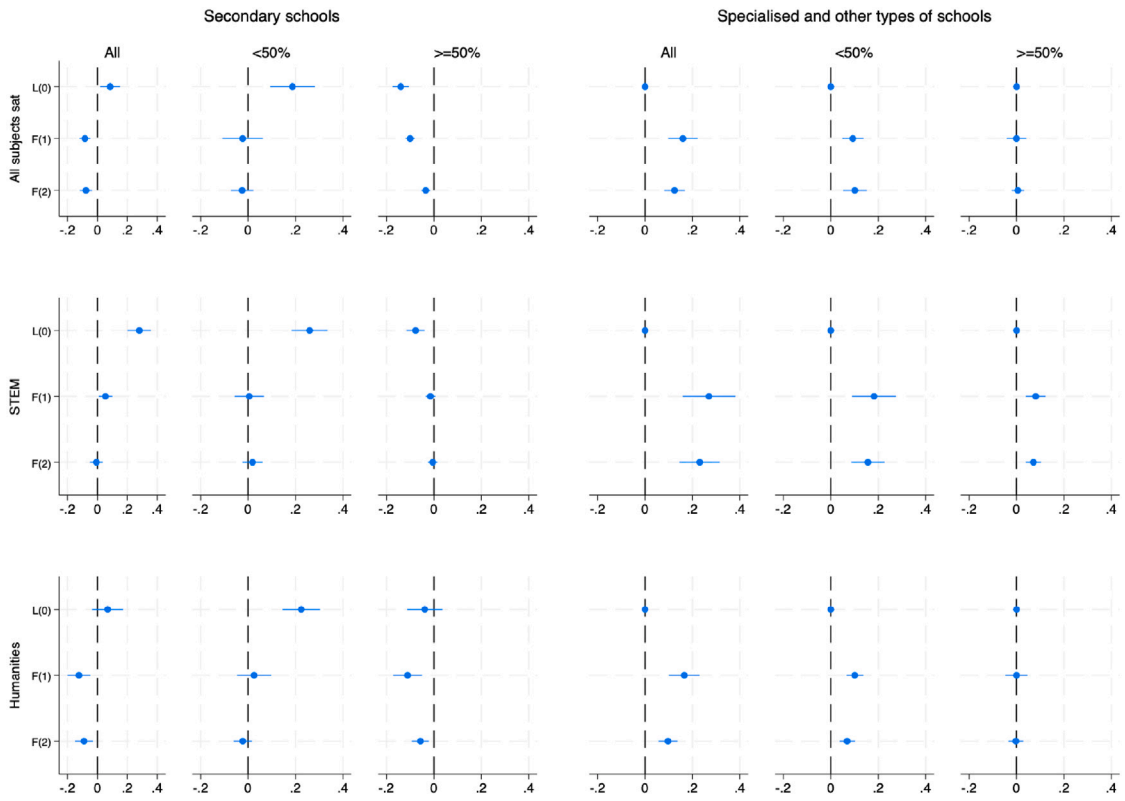

Fig. 10. Event study results by school type, average scores (ln).
Notes: The Figure presents the results of the event study model for the dependent variables natural logarithm of average scores for *All subjects sat* (top row), *STEM* (middle row), and *Humanities* (bottom row). The plotted coefficients are generated using Eqs. (1) and (2). The first and fourth vertical panels present the results for all students. The second and fifth vertical panels present the results for the students with scores below median over 2018–2019. The third and sixth vertical panel shows the results for the student with scores above median over 2018–2019. The first three vertical panels present the results for secondary schools. The second three vertical panels present the results for other types of schools, including liceums, gymnasiums, and other types of specialized schools. The treatment group are students studying in decentralized hromadas in 2018–2019, while the control group consists of hromadas not yet decentralized during this time period.

enabled by fiscal autonomy. Fig. 2 demonstrated that the school-level spending increased from approximately 15 million UAH in 2018 to nearly 21 million UAH in 2020, a trajectory that aligns temporally with the strongest gains observed among below-median students.

To examine whether educational expenditures are indeed associated with student achievement within decentralized hromadas, we estimate the following fixed effects model:

$$Y_{ish t} = \beta_1 \ln(\text{EdExp}_{ht}) + \beta_2 \text{Urban}_s + \beta_3 \text{Female}_i + \beta_4 \text{Age}_i + \beta_5 \ln(\text{Income}_{ht}) + \theta_s + \psi_h + \lambda_t + \varepsilon_{ish t} \quad (3)$$

where $Y_{ish t}$ is the natural logarithm of the average test score for student i attending school type s in hromada h at time t, and $\ln(\text{EdExp}_{ht})$ measures either the logarithm of educational expenses per school or per student in hromada h at time t, adjusted for inflation. The specification controls for school location (Urban_s), student gender (Female_i) and age (Age_i), real per capita hromada income ($\ln(\text{Income}_{ht})$), and includes school type (θ_s), hromada (ψ_h), and year (λ_t) fixed effects. We also estimate an extended specification that interacts urban status with per capita income to capture differential returns to community affluence across urban and rural settings:

$$Y_{ish t} = \beta_1 \ln(\text{EdExp}_{ht}) + \beta_2 \text{Urban}_s + \beta_3 \text{Female}_i + \beta_4 \text{Age}_i + \beta_5 \ln(\text{Income}_{ht}) + \beta_6 (\text{Urban}_s \times \ln(\text{Income}_{ht})) + \theta_s + \psi_h + \lambda_t + \varepsilon_{ish t} \quad (4)$$

Standard errors are clustered at the hromada level. The sample is restricted to students in decentralized hromadas during 2018–2019, before the nationwide completion of decentralization in 2020, providing a focused estimate of how increased local educational spending translates into student outcomes among communities that voluntarily adopted fiscal autonomy. For completeness, we also report results using the full 2018–2021 sample in Tables A.1 and A.2 in the Appendix.

The results in Tables 4 and 5 confirm a positive and statistically significant association between educational expenditures and student achievement. A 10% increase in spending per school corresponds to approximately a 1% improvement in test scores across all subject categories (Table 4), while the per-student specification yields a somewhat smaller but still significant elasticity of approximately 0.7% (Table 5). These findings are consistent with the broader literature linking targeted funding increases to improved academic outcomes (see e.g., Lafortune et al., 2018).

The estimates also reveal that students in urban hromadas outperform rural peers by approximately 20%, though this gap narrows with increasing hromada affluence: the interaction between urban status and per capita income is negative and significant, indicating that the urban advantage diminishes in wealthier communities. Female students outperform males by 18%–24% depending on the subject, consistent with cross-national evidence on gender gaps in academic achievement (e.g., Marks, 2008; OECD, 2019).

These correlational findings support the interpretation that decentralization improved student outcomes in part by enabling communities to increase and better target educational investment. However, we must acknowledge important caveats. We do not directly measure efficiency in resource allocation. Other factors may influence the relationship between decentralization and achievement, including changes in teacher quality, administrative capacity, or curriculum implementation. The evidence strongly suggests that improved allocation and utilization of resources constitute an important channel, but the precise mechanisms

Table 4
Fixed effects estimates: Test scores and educational expenses per educational establishment.

	(1) Compulsory	(2) All subjects sat	(3) STEM	(4) Humanities	(5) Compulsory	(6) All subjects sat	(7) STEM	(8) Humanities
Educational expenses per school (ln)	0.110***	0.104***	0.101**	0.075**	0.111***	0.105***	0.105**	0.076**
	(0.042)	(0.039)	(0.049)	(0.035)	(0.042)	(0.040)	(0.049)	(0.036)
Urban (d)	0.225***	0.187***	0.173***	0.184***	1.188**	1.416**	2.138***	0.869
	(0.038)	(0.034)	(0.039)	(0.036)	(0.601)	(0.546)	(0.737)	(0.667)
Female (d)	0.211***	0.177***	0.168***	0.173***	0.211***	0.177***	0.168***	0.173***
	(0.008)	(0.007)	(0.011)	(0.008)	(0.008)	(0.007)	(0.011)	(0.008)
Age (years)	−0.096***	−0.089***	−0.108***	−0.099***	−0.096***	−0.089***	−0.108***	−0.099***
	(0.013)	(0.012)	(0.017)	(0.012)	(0.013)	(0.012)	(0.017)	(0.012)
Per capita income (ln)	0.004	0.012	0.085	−0.058	0.092	0.125	0.261*	0.005
	(0.140)	(0.124)	(0.137)	(0.113)	(0.137)	(0.126)	(0.148)	(0.123)
Urban × Per capita income					−0.107	−0.136**	−0.218***	−0.076
					(0.067)	(0.061)	(0.081)	(0.074)
Constant	3.062**	2.977**	2.532*	4.353***	2.238*	1.924	0.889	3.767***
	(1.312)	(1.214)	(1.330)	(1.062)	(1.255)	(1.193)	(1.383)	(1.101)
Observations	21,080	21,080	15,751	21,068	21,080	21,080	15,751	21,068
R-squared	0.453	0.452	0.341	0.455	0.453	0.452	0.342	0.455
School type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hromada FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. The table presents the results of the fixed effects model, where the dependent variables are natural logarithms of average test scores for either *Compulsory subjects* (Ukrainian Language and Literature, Mathematics, and History of Ukraine), or *All subjects sat* (compulsory subjects plus an elective), or STEM subjects, or Humanities subjects. *Educational expenses per school* and *Per capital income* are hromada-year level variables adjusted for inflation. *Urban* is a dummy equal to one if a student comes from a city, and zero otherwise. *Female* is a dummy equal to one if a student is female, and zero otherwise. *Age* measures the age of a student. Financial data is available only for decentralized hromadas.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Table 5
Fixed effects estimates: Test scores and educational expenses per student.

	(1) Compulsory	(2) All subjects sat	(3) STEM	(4) Humanities	(5) Compulsory	(6) All subjects sat	(7) STEM	(8) Humanities
Educational expenses per student (ln)	0.074***	0.069***	0.030	0.062***	0.075***	0.071***	0.034	0.063***
	(0.026)	(0.024)	(0.036)	(0.023)	(0.026)	(0.024)	(0.037)	(0.023)
Urban (d)	0.228***	0.190***	0.175***	0.186***	1.207**	1.433***	2.119***	0.893
	(0.038)	(0.034)	(0.040)	(0.036)	(0.596)	(0.540)	(0.749)	(0.655)
Female (d)	0.212***	0.178***	0.168***	0.173***	0.212***	0.178***	0.168***	0.173***
	(0.008)	(0.007)	(0.011)	(0.008)	(0.008)	(0.007)	(0.011)	(0.008)
Age (years)	−0.097***	−0.089***	−0.108***	−0.099***	−0.097***	−0.089***	−0.108***	−0.099***
	(0.013)	(0.012)	(0.017)	(0.012)	(0.013)	(0.012)	(0.017)	(0.012)
Per capita income (ln)	0.012	0.021	0.119	−0.060	0.102	0.135	0.292*	0.004
	(0.139)	(0.124)	(0.138)	(0.115)	(0.136)	(0.126)	(0.150)	(0.124)
Urban × Per capita income					−0.109	−0.138**	−0.216***	−0.078
					(0.066)	(0.060)	(0.083)	(0.073)
Constant	3.818***	3.698***	3.507***	4.799***	2.987**	2.642**	1.899	4.199***
	(1.246)	(1.124)	(1.210)	(0.984)	(1.203)	(1.121)	(1.298)	(1.041)
Observations	21,080	21,080	15,751	21,068	21,080	21,080	15,751	21,068
R-squared	0.453	0.451	0.341	0.455	0.453	0.452	0.341	0.455
School type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hromada FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. The table presents the results of the fixed effects model, where the dependent variables are natural logarithms of average test scores for either *Compulsory subjects* (Ukrainian Language and Literature, Mathematics, and History of Ukraine), or *All subjects sat* (compulsory subjects plus an elective), or STEM subjects, or Humanities subjects. *Educational expenses per student* and *Per capital income* are hromada-year level variables adjusted for inflation. *Urban* is a dummy equal to one if a student comes from a city, and zero otherwise. *Female* is a dummy equal to one if a student is female, and zero otherwise. *Age* measures the age of a student. Financial data is available only for decentralized hromadas.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Table A.1
Fixed effects estimates using 2018–2021 sample: Test scores and educational expenses per educational establishment.

	(1) Compulsory	(2) All subjects sat	(3) STEM	(4) Humanities	(5) Compulsory	(6) All subjects sat	(7) STEM	(8) Humanities
Educational expenses per school (ln)	0.023*	0.023*	0.013	0.030**	0.024*	0.023*	0.014	0.030**
	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)
Urban (d)	0.159***	0.143***	0.124***	0.136***	0.662***	0.499**	0.707**	0.302
	(0.008)	(0.007)	(0.008)	(0.007)	(0.243)	(0.224)	(0.283)	(0.213)
Female (d)	0.160***	0.175***	0.106***	0.185***	0.160***	0.175***	0.106***	0.185***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Age (years)	−0.068***	−0.062***	−0.049***	−0.066***	−0.068***	−0.062***	−0.049***	−0.066***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
Per capita income (ln)	−0.067***	−0.056**	−0.079***	−0.052**	−0.022	−0.024	−0.027	−0.037
	(0.024)	(0.023)	(0.025)	(0.021)	(0.028)	(0.024)	(0.029)	(0.024)
Urban × Per capita income					−0.055**	−0.039	−0.063**	−0.018
					(0.026)	(0.024)	(0.031)	(0.023)
Constant	4.689***	4.618***	4.524***	4.631***	4.254***	4.311***	4.028***	4.487***
	(0.375)	(0.360)	(0.396)	(0.356)	(0.379)	(0.356)	(0.407)	(0.360)
Observations	164,923	165,050	149,929	164,762	164,923	165,050	149,929	164,762
R-squared	0.260	0.254	0.126	0.251	0.260	0.254	0.126	0.251
School type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hromada FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. The table presents the results of the fixed effects model, where the dependent variables are logarithms of average test scores for either *Compulsory subjects* (Ukrainian Language and Literature, Mathematics, and History of Ukraine), or *All subjects sat* (compulsory subjects plus an elective), or STEM subjects, or Humanities subjects. *Educational expenses per school* and *Per capital income* are hromada-year level variables adjusted for inflation. *Urban* is a dummy equal to one if a student comes from a city, and zero otherwise. *Female* is a dummy equal to one if a student is female, and zero otherwise. *Age* measures the age of a student. Financial data is available only for decentralized hromadas.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

through which fiscal autonomy translates into educational gains require further investigation.

A further limitation is that our fiscal data measure total educational expenditures at the hromada level but do not disaggregate spending into specific categories such as teacher recruitment, instructional materials, or infrastructure. Future research with more granular fiscal data could identify which types of local investment are most effective at improving student outcomes across the achievement distribution.

7. Conclusions

This study demonstrates that fiscal decentralization can serve as an equity-enhancing policy instrument in education, though with important trade-off between supporting struggling students and maintaining excellence. Using comprehensive student-level data and Ukraine's staggered reform roll out, we provide causal evidence that local fiscal autonomy improved outcomes specifically in previously under-resourced communities while leaving wealthier areas largely unaffected. This finding contributes to the decentralization literature by showing that fiscal autonomy's benefits are not uniformly distributed but instead concentrate where resource constraints were previously most binding.

Our results reveal a consistent pattern: the reform succeeded in directing resources toward foundational skills and underperforming students but struggled to maintain support for high achievers, particularly in humanities subjects. This reflects how local decision-makers prioritized breadth over depth when given fiscal autonomy — a rational response to competing demands with limited resources, but one that reshaped the distribution of educational excellence. The exception in STEM subjects, where investments benefited students across the performance distribution, suggests that certain types of educational resources (laboratories, equipment, specialized instruction) generate broader returns than others. These findings carry important implications for education policy in decentralizing contexts. First, fiscal autonomy alone does not guarantee improved outcomes; effectiveness depends critically on local capacity and baseline resource levels. Second, policymakers must anticipate that decentralization will reshape rather than uniformly improve educational quality, creating winners and losers across subjects, regions, and performance levels. Third, systems relying heavily on private supplementation (such as tutoring) may experience unexpected dynamics as public quality changes, requiring policies that account for public–private interactions.

For Ukraine specifically, our results suggest that while decentralization has advanced educational equity, sustaining support for high achievers may require targeted interventions — perhaps centralized funding for gifted programs or advanced coursework — that complement local autonomy rather than leaving all decisions to hromadas. More broadly, countries pursuing decentralization should design reforms that explicitly balance equity and excellence objectives, rather than assuming fiscal autonomy will automatically achieve both.

The release of administrative education data in Ukraine represents an important step toward transparency and evidence-based policymaking. These data should be actively utilized not only to evaluate decentralization's ongoing effects but also to identify which local contexts and practices generate the best outcomes, informing adaptive policies that build on decentralization's successes while mitigating its limitations. In doing so, any account of structural changes across all spheres of societal life must take into consideration the impact of the Russian military invasion, which has profoundly reshaped governance, resource distribution, and community resilience. Future research in the Ukrainian context should examine the specific governance practices and resource allocation decisions that distinguish successful from unsuccessful hromadas, providing actionable guidance for optimizing decentralized educational systems.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

See Tables A.1 and A.2.

Table A.2
Fixed effects estimates using 2018–2021 sample: Test scores and educational expenses per student.

	(1) Compulsory	(2) All subjects sat	(3) STEM	(4) Humanities	(5) Compulsory	(6) All subjects sat	(7) STEM	(8) Humanities
Educational expenses per student (ln)	0.027***	0.028***	0.002	0.037***	0.030***	0.030***	0.005	0.038***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Urban (d)	0.160***	0.145***	0.125***	0.138***	0.740***	0.578**	0.714**	0.401*
	(0.008)	(0.007)	(0.008)	(0.007)	(0.244)	(0.225)	(0.285)	(0.214)
Female (d)	0.160***	0.175***	0.106***	0.185***	0.160***	0.175***	0.106***	0.185***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Age (years)	−0.068***	−0.062***	−0.049***	−0.066***	−0.068***	−0.062***	−0.049***	−0.066***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
Per capita income (ln)	−0.073***	−0.062***	−0.079***	−0.059***	−0.022	−0.024	−0.027	−0.036
	(0.024)	(0.022)	(0.025)	(0.021)	(0.028)	(0.024)	(0.031)	(0.023)
Urban × Per capita income					−0.063**	−0.047*	−0.064**	−0.029
					(0.027)	(0.024)	(0.031)	(0.023)
Constant	4.763***	4.676***	4.716***	4.706***	4.247***	4.291***	4.197***	4.472***
	(0.288)	(0.275)	(0.297)	(0.269)	(0.310)	(0.284)	(0.336)	(0.285)
Observations	164,923	165,050	149,929	164,762	164,923	165,050	149,929	164,762
R-squared	0.260	0.254	0.126	0.251	0.260	0.254	0.126	0.251
School type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hromada FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. The table presents the results of the fixed effects model, where the dependent variables are logarithms of average test scores for either *Compulsory subjects* (Ukrainian Language and Literature, Mathematics, and History of Ukraine), or *All subjects sat* (compulsory subjects plus an elective), or STEM subjects, or Humanities subjects. *Educational expenses per student* and *Per capital income* are hromada-year level variables adjusted for inflation. *Urban* is a dummy equal to one if a student comes from a city, and zero otherwise. *Female* is a dummy equal to one if a student is female, and zero otherwise. *Age* measures the age of a student. Financial data is available only for decentralized hromadas.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Data availability

Mendeley Data Repository:

Ukraine's School Graduate Outcomes (Original data), including the replication package (Mendeley Data)

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